

1 **Downhole Connector**

2
3 The present invention relates to apparatus and method for
4 running and setting apparatus in a well bore and in
5 particular to apparatus and method for setting a liner in
6 a well bore, where the liner is used as part of the drill
7 string and is left cemented in place in the well, after
8 drilling is complete.

9
10 In drilling and completing well bores it is typical to
11 insert liner into the well bore. The liner may be
12 inserted through casing and tied back to provide a
13 production string in a pre-drilled well bore.
14 Alternatively the liner may form part of the drill string
15 and be run into the well bore during drilling. When the
16 liner reaches its desired location, any tools such as the
17 drill bit or mud motors may be removed from the string,
18 and cement is typically passed down the liner to fill the
19 annulus between the liner and the well bore or casing
20 wall. The string above the liner is then detached and
21 removed, leaving a cemented liner within the well bore.

22
23 Various tools have been developed to releasably attach to
24 the liner. These are generally termed liner running and

1 setting tools. The tools must also allow for torque to be
2 transmitted through the liner when a drill bit is located
3 below the liner. Additionally it has been found
4 advantageous to rotate and reciprocate the liner during
5 cementing to distribute the cement more evenly and thus
6 the tools need to allow for this. Further, some
7 operations now require the ability to 're-stab' i.e. to
8 reconnect to the liner after cementing. This procedure is
9 also advantageous if the tool is used as a connector to
10 other apparatus than liners e.g. packers.

11
12 The most basic of these running and setting tools consist
13 of a screw thread on a setting tool connected to the
14 drill string engaging a matching thread on a setting
15 sleeve at the top of the liner. Release is effected by
16 unscrewing the thread when the liner is cemented. For
17 drilling applications, these tools typically have a left
18 hand thread which is releasable by right hand torque.
19 This is because the drill string has joints connected by
20 right hand threads, which are rotated clockwise in use.
21 It was found that setting tools having right hand threads
22 had make-up torque applied to them during drilling and,
23 as a result, when the tool was released, by rotating the
24 drill string anti-clockwise, joints would separate in the
25 string preferentially to release of the liner.

26
27 However, as typical setting tools have left hand threads,
28 torque transmitting mechanisms require to be included in
29 the tools to allow the liner to rotate with the drill
30 string and the drill bit. Some tools use spring loaded
31 dogs or collets on the setting tool to engage
32 longitudinal slots on the setting sleeve. These matings
33 allow for relative longitudinal movement between the

1 setting tool and sleeve while circumferentially securing
2 the two together so that torque can be transmitted
3 between both. In this way they may be considered as a
4 clutch since they must be able to be 'declutched' to
5 release the sleeve from the setting tool. The setting
6 tool and sleeve will turn together whether the string is
7 rotated clockwise or anti-clockwise. Due to the
8 mechanisms and moving parts required, a disadvantage of
9 these tools is that debris within the well bore can
10 impede their action, causing the tool to malfunction. A
11 further disadvantage of many of these tools is that to be
12 releasable, a drop ball or bomb must be landed on the
13 tool through the work string. The drop ball, or bomb
14 blocks all or part of the bore of the liner and therefore
15 impedes efficient cementing.

16
17 It is therefore an object of at least one embodiment of
18 the present invention to provide a downhole releasable
19 coupling through which torque can be transmitted without
20 make-up torque being applied to screw threads in the
21 coupling.

22
23 It is a further object of at least one embodiment of the
24 present invention to provide a drilling liner system for
25 use on a drill string through which torque can be
26 transmitted without make-up torque being applied to screw
27 threads in the coupling.

28
29 According to a first aspect of the present invention
30 there is provided a downhole releasable coupling, the
31 coupling comprising a first substantially tubular member
32 having a bore therethrough, a first screw thread around
33 an outer surface thereof, one or more raised portions

1 arranged circumferentially on the outer surface, the
2 raised portions defining a first face surrounding the
3 member and substantially perpendicular to the outer
4 surface, the first face being directed toward the first
5 screw thread, the first face having a plurality of first
6 projections, each first projection having a substantially
7 first straight portion arranged parallel to the bore and
8 a first sloping portion, joining an apex of the first
9 projection to a base of an adjacent projection; and a
10 second tubular member having a bore therethrough, a
11 second screw thread around an inner surface thereof, one
12 or more raised portions arranged circumferentially on an
13 outer surface thereof, the raised portions defining a
14 second face surrounding the member and substantially
15 perpendicular to the outer surface, the second face being
16 at an end of the member, the second face having a
17 plurality of second projections, each second projection
18 having a substantially second straight portion arranged
19 parallel to the bore and a second sloping portion,
20 joining an apex of the second projection to a base of an
21 adjacent projection; wherein the first tubular member
22 slides within the second tubular member, the first and
23 second screw threads mate and on part engagement of the
24 screw threads, the first and second straight portions can
25 meet to thereby transfer torque when a member is rotated
26 in the direction of the screw threads.

27

28 The projections may be considered as teeth on a ratchet.
29 In this way opposing teeth abut so that torque is
30 transferred between the members in a uni-directional
31 manner. As the projections meet before the screw threads
32 end, there is no make-up torque applied to the threads.
33 As soon as the direction of rotation is reversed the

1 members move relative to each other and unscrew. This
2 provides rapid release, as there is no make-up torque to
3 overcome before movement can occur.

4

5 Preferably the screw threads are right hand screw
6 threads. In this way, torque can be transmitted on
7 rotation of a work string.

8

9 Advantageously the screw threads are multiple start
10 threads. Preferably the screw threads are double start
11 screw threads. Preferably also the screw threads are
12 square. Additionally the screw threads may have generous
13 lead in edges so that the coupling can be re-engaged
14 easily.

15

16 Preferably the tubular members are initially releasably
17 attached to each other by a shearing means. Preferably
18 the shearing means is by one or more shear pins. The
19 shear pins may be arranged through apertures on the
20 second member and rest in pockets in the outer surface of
21 the first member. Advantageously the apertures and the
22 pockets align when the first and second straight portions
23 abut. The use of shearing means allows a predetermined
24 torque value to be set at which decoupling will occur.

25

26 Additionally at least one o-ring may be arranged at
27 either end of the screw thread circumferentially around
28 the tubular member. This prevents the ingress of debris
29 to the thread. Preferably the o-rings are retained in
30 circumferential grooves on the outer surface of the first
31 tubular member.

32

1 An embodiment may comprise four raised portions on each
2 tubular member; each face providing two equidistantly
3 spaced projections; four apertures being arranged through
4 the raised portions of the second tubular; shear pins
5 being located through each aperture into four pockets on
6 the outer surface of the first tubular; and an o-ring
7 located into a groove at each end of the screw thread of
8 the first tubular member.

9
10 According to a second aspect of the present invention
11 there is provided a drilling liner system comprising a
12 running tool having a substantially cylindrical first
13 body and a first bore therethrough, the first body having
14 an end adapted for connection to a drill string, and a
15 setting sleeve having a substantially cylindrical second
16 body and a second bore therethrough, the second body
17 having an end adapted for connection to a liner, wherein
18 the running tool and the setting sleeve couple via a
19 detachable coupling according to the first aspect.

20
21 Preferably the running tool includes the first tubular
22 and the setting sleeve includes the second tubular
23 member.

24
25 Preferably the bores align to provide a continuous
26 central bore through the system.

27
28 More preferably the screw threads are right hand screw
29 threads. This arrangement allows torque to be transmitted
30 by rotation of the drill string. Further the system can
31 be reciprocated and rotated as it will simply follow the
32 motion of the drill string until the setting sleeve is
33 held in a fixed position.

1
2 Preferably the running tool includes one or more first
3 radial outlets arranged circumferentially around the
4 first body, the setting sleeve includes one or more
5 second radial outlets arranged circumferentially around
6 the second body, and in a first position the first and
7 second radial outlets are aligned and fluid can pass
8 radially from the system. Alignment is effected by moving
9 the running tool and setting sleeve relative to each
10 other by rotation of one against the other to relocate on
11 the screw thread. This provides selective radial fluid
12 flow from the tool which can be used to distribute cement
13 more effectively and wash out the well bore.

14
15 Preferably there are four radial ports in each body. More
16 preferably the first position occurs when the first and
17 second screw threads are partially engaged.

18
19 Optionally the system may further comprise a seal stem,
20 the stem having a substantially cylindrical third body
21 with a third bore therethrough, a third screw thread on
22 an outer surface thereof for engagement to the second
23 screw thread, and a polished end distal to the screw
24 thread. Once the running tool is decoupled from the
25 setting sleeve, the stem can be connected to the setting
26 sleeve to provide a polished bore receptacle to the
27 setting sleeve for tie-back purposes.

28
29 According to a third aspect of the present invention,
30 there is provided a method of setting a liner in a well
31 bore, the method comprising the steps;

32

- 1 (a) providing a drilling liner system according to the
- 2 second aspect;
- 3 (b) connecting the running tool and setting sleeve by
- 4 engaging the screw threads until the first and
- 5 second straight portions meet;
- 6 (c) connecting the running tool to a drill string and
- 7 the setting sleeve to a liner;
- 8 (d) transmitting torque to the liner by rotating the
- 9 drill string in a first direction;
- 10 (e) cementing the liner in place by introducing cement
- 11 slurry axially into the bore, to allow the slurry to
- 12 exit the liner and locate between the liner and the
- 13 well bore; and
- 14 (f) rotating the drill string in a reverse direction
- 15 until the screw threads disengage; and
- 16 (g) removing the running tool from the well bore.

17
18 Preferably the first direction is right hand rotation.

19
20 The method may include the step of removing an assembly
21 from the well bore through the liner when the system is
22 connected to the liner. The assembly may be a drilling
23 assembly or a mud motor assembly.

24
25 Preferably the method includes the step of shearing the
26 shearing means when the drill string is rotated in the
27 reverse direction.

28
29 Preferably also the method includes the step of aligning
30 the radial ports to expel fluid or cement from the
31 system.

32

1 Preferably the method includes the step of rotating and
2 reciprocating the system on the drill string during
3 cementing.

4

5 Preferably the method includes the following steps:

- 6 (a) following rotation in the first direction, noting a
7 first circulation pressure in the well bore;
8 (b) applying liner weight to bottom of well and partly
9 releasing the running tool from the setting sleeve
10 to shear the shear screws and align the radial
11 ports;
12 (c) confirming that circulation pressure has dropped
13 from the first circulation pressure;
14 (d) on pressure loss rotating the drill string until the
15 straight portions meet; and
16 (e) confirming circulation pressure has returned to
17 first circulation pressure.

18 These steps provide confirmation that, firstly, partial
19 release has occurred and, secondly, that the running tool
20 can be released after cementing.

21

22 Embodiments of the present invention will now be given,
23 by way of example only, with reference to the
24 accompanying Figures of which:

25

26 Figure 1 is a part cross-section of the view of the
27 downhole connector according to an embodiment of the
28 present invention where Figure 1(a) illustrates the
29 first tubular member and Figure 1(b) illustrates the
30 second tubular member to be coupled thereto;

31

1 Figure 2 is a schematic representation of the
2 circumferential profile of a portion of the
3 connector of Figure 1;

4
5 Figure 3 is a schematic representation of a drilling
6 liner system according to an embodiment of the
7 present invention, illustrated in (a) run in
8 position, (b) partial release or by-pass position
9 and (c) released position; and

10
11 Figure 4 is a part cross-sectional view of a liner
12 stem for use in the drilling liner system of Figure
13 3.

14
15 Referring initially to Figure 1 of the drawings, there is
16 provided a releasable coupling, generally indicated by
17 reference number 10, according to a first embodiment of
18 the present invention. Coupling 10 comprises two parts,
19 the first part being an upper tubular member 12 and the
20 second being a lower tubular member 14 shown in Figures
21 1(a) and (b) respectively. The upper 12 and lower 14
22 tubular members are releasably coupled as described
23 hereinafter.

24
25 The upper tubular member 12 comprises a cylindrical body
26 16 and central bore 18 therethrough. At the upper end 20
27 is located a downhole attachment 22 for connecting the
28 tubular member 12 to a tool or workstring located above.
29 Typically downhole attachment 22 would be a box section
30 as is commonly known in the art. Toward the upper end 20
31 of tubular member 12 is provided a raised portion 24 on
32 the outer surface 26 of the tubular member 12. Raised
33 portion 24 comprises four substantially longitudinal

1 sections 28 lying longitudinally on the outer surface 26.
2 Longitudinal portions 28 are arranged circumferentially
3 around the body 16.

4
5 Working towards a lower end 30 of the member 12 there is
6 next located pockets 32. In the embodiment shown there
7 are four pockets 32 arranged circumferentially on the
8 outer surface 26 of the body 16. Pockets 32 are recesses
9 into which shear screws (not shown) may engage. Below
10 the pockets 32 lies an annular groove 34 into which an O-
11 ring 36 is located. Groove 34 preferably has edges which
12 taper towards the bore 18. The O-ring 36 seals a screw
13 portion 38 of the member 12 from the downhole environment
14 in use.

15
16 Screw portion 38 is a double start screw thread formed on
17 the outer surface 26 of the body 16. The screw thread is
18 a square screw thread and is a right hand screw thread.
19 Below the screw portion 38 lies three annular grooves 40
20 into which three further seals in the form of O-rings 42
21 locate. O-rings 42 provide the same advantages as O-
22 rings 36 and together they can seal off the screw thread
23 portion 38.

24
25 Finally, below the grooves 40 are located radial ports
26 44. Four radial ports 44 are arranged circumferentially
27 around the body 16 of the member 12. Each port 44
28 provides a connection from the bore 18 of the member
29 through the wall 46 of the member 12 to the outer surface
30 26.

31 Lower tubular member 14 comprises a cylindrical body 48
32 having an internal bore 50 therethrough. At a lower end
33 52 of the member 14 is arranged a downhole attachment 54

1 to couple the member 14 to a tool or workstring arranged
2 below the member 14. It will be understood that
3 attachment 54 will typically be a pin section as is known
4 in the art.

5
6 In bore 50 is arranged an inner surface 56. Inner
7 surface 56 comprises a screw thread portion 58 whose
8 threads match and co-operate with the screw thread
9 portion 38 of tubular member 12. In addition, four
10 radial ports 60 are arranged circumferentially on the
11 inner surface 56 to provide a passage for fluid from the
12 bore 50 to the outer surface 62 of the member 14. There
13 are four radial ports 60 arranged circumferentially
14 around the body 48.

15
16 On the outer surface 62 of the member 14 are located four
17 raised portions 64. The raised portions 64 are arranged
18 circumferentially on the body 48. Upper ends 66 of the
19 raised portions extend beyond the upper end 68 of the
20 member 14. Arranged on each raised portion 64 is an
21 aperture 70. Aperture 70 provides a connection from the
22 outer surface 62 to the inner surface 56 of the body 48.
23 Aperture 70 is used to fit a shear screw (not shown)
24 through to the pocket 32 of the member 12. It will be
25 appreciated that any number of aperture/pocket
26 combinations can be used and that the selection of the
27 shear screw size and material, together with the number
28 used will determine the torque which can be applied
29 between the upper 12 and lower 14 tubular members to
30 effect a de-coupling.

31
32 Reference is now made to Figure 2 of the drawings which
33 provides in two parts, (a) and (b), the raised portions

1 24,64 of the tubular members 12 and 14 respectively.
2 Figure 2(a) illustrates the raised portion 24 in
3 longitudinal profile which may be described as a
4 developed circumference. The four longitudinal portions
5 28a-d provide an edge 72 which faces the pockets 32 on
6 the body 16. Edge 72 can be considered as providing a
7 face 74 perpendicular to the outer surface 26 of the
8 member 12. Face 74 includes two projections 76a,b. Each
9 projection has a straight portion 78a,b which lies
10 longitudinally with the portions 28 and parallel with the
11 bore 18. Each straight portion 78 arrives at an apex
12 80a,b from a base 82a,b. Accordingly there are two
13 sloping sections 84a,b which join the apexes 80a,b to the
14 bases 82a,b. It will be noted that in this embodiment there
15 are two projections 76a,b originating on two portions 28.
16 It will be appreciated however, that any number of raised
17 portions will be designed into the coupling 10.

18

19 Referring now to Figure 2(b), there is shown the upper
20 end 68 of member 14 having a complimentary matching face
21 86 to that of face 74. Face 86 comprises two projections
22 88a,b. The projections each have a straight portion
23 90a,b arranged parallel to the bore 50. Each straight
24 section 90a,b also comprises an apex 92a,b and a base
25 94a,b. Again adjacent projections 88a,b are joined by a
26 sloping surface 96a,b which connect the adjoining apexes
27 92a,b with bases 94a,b.

28

29 Reference is now made to Figure 3 of the drawings which
30 illustrates in the three steps, shown as (a), (b) and
31 (c), the tool in use. In this embodiment the tool is
32 described with reference to a drilling liner system with
33 a coupling 10 being part of a drill string (not shown).

1 Like parts to those of Figures 1 and 2 have been given
2 the same reference numerals to aid clarity. Thus in use,
3 referring initially to Figure 3(a), coupling 10 is in a
4 made-up configuration. This will be the configuration
5 used on run in of a drilling liner system, generally
6 indicated by reference numeral 100, into a well bore (not
7 shown). The upper tubular member 12 will now be
8 recognised as a liner running tool while the lower
9 tubular member will be recognised as a liner setting
10 sleeve.

11

12 In this configuration the upper tubular member 12 is
13 connected to an upper section of drill string by use of
14 the box section 22 and the lower tubular member 14 is
15 connected to a lower portion of drill string through the
16 pin section at 54. The tubular members 12,14 are
17 connected by inserting upper tubular member 12 into lower
18 tubular member 14 and engaging the screw threads 38,58.
19 The threads are fully engaged until such point that the
20 straight portions 78, 90 abut and prevent any further
21 rotational movement of one tubular member independent of
22 the other tubular member. Thus any torque applied to the
23 upper tubular member 12 in a clockwise direction will
24 cause the lower tubular member 14 to rotate with the
25 upper tubular member 12. In this way torque is
26 transmitted through the system 100.

27

28 The upper and lower tubular members 12,14 are further
29 secured via shear screws 98, located through the aperture
30 70 of the lower tubular member 14 and into a pocket 32 of
31 the upper tubular member 12. It will be appreciated that
32 the shear screws 98 can be selected to predetermine the
33 torque applied to the coupling 10 at which they will

1 shear and detach the coupling 10 as described
2 hereinafter.

3
4 It should be noted that a clear bore 102 is provided through
5 the system 100, as a passage from bore 18 through bore
6 50. Additionally seals 36,42 isolate the screw threads
7 38,58 from the passage of fluid through the bore 102.
8 Fluid in the drill string will pass through the bore 102
9 as the radial ports 44,60 in each tubular member 12,14
10 respectively are misaligned. Thus while the drill string
11 is rotated in a typical clockwise direction the coupling
12 10 is attached and the drill liner system 100 will act as
13 if part of the drill string, transferring torque to any
14 components or tools attached below the system 100.

15
16 As shown in Figure 3(b) to detach the system the upper
17 tubular member 12 is rotated anti-clockwise. While it is
18 known that rotating the drill string in an anti-clockwise
19 direction risks releasing tubing joints within the drill
20 string, these tubing joints will naturally have made-up
21 torque applied to them. By virtue of the straight
22 portions 78,90 meeting on the upper and lower tubular
23 members 12,14, torque is transferred through these
24 surfaces and thus there is no made-up torque on the
25 threads and any anti-clockwise rotation will immediately
26 release the faces 78,90 from each other. Continuous
27 turning of the upper tubular member 12 will cause the
28 screw threads 38,58 to unscrew and thereby move the upper
29 tubular member 12 away from lower tubular member 14.

30
31 On turning the drill string anti-clockwise it is the
32 shear screws 98 which will shear at a predetermined torque and
33 the coupling 10 will detach. As the shear screws 98

1 shear, the straight portions 78,90 will come away from
2 each other and by virtue of the screw threads, the
3 tubular members are unscrewed from each other.
4
5 In the preferred embodiment, as shown in Figure 3(b),
6 anti-clockwise rotation of the upper member 12 relative
7 to the lower member 14 by only two turns causes the
8 radial ports 44,60 to become aligned. In aligning the
9 radial ports 44,60 fluid flow can pass from the bore 102
10 to the annulus 104 outside the system 100. Such movement
11 of fluid will cause a change in fluid pressure at the top
12 of the well bore which can be noted by the operators.
13 Notification of such a pressure change informs the
14 operators that the coupling 10 has detached successfully.
15 At this point fluid could be pumped down the bore 102 to
16 be expelled through the radial ports 44,60 to provide for
17 a cementing or cleaning action within the annulus 104.
18
19 Further rotation of the upper tubular member 12 relative
20 to the lower tubular member 14 in the anti-clockwise
21 direction will eventually cause the screw threads 38,58
22 to be completely released from each other and accordingly
23 the upper tubular member 12 becomes entirely detached
24 from the lower tubular member 14. In this configuration
25 the lower tubular member 14 may be left within a well
26 bore, while the upper tubular member 12 can be removed
27 from the well bore upon the drill string.
28
29 It should also be noted that simply by reinserting the
30 upper tubular member 12 into the lower tubular member 14
31 the coupling 10 can be reattached as the threads 38 have
32 a long lead into the threads 58. Thus rotation of the
33 drill string, including the upper tubular 12 into the

1 lower tubular member 14 will cause the coupling to be
2 reattached. The reattachment can be made up to the point
3 where the sloping surfaces 78,90 meeting. In this
4 configuration the lower tubular member 14 may also be
5 removed from the well bore.

6
7 The embodiment described in Figure 3 is ideally suited to
8 be used for setting a liner in a well bore. The method
9 of setting such a liner in a well bore would be to run a
10 liner with a desired bottom hole assembly. Connect the
11 drilling line system 100 to the drill pipe and run in the
12 well bore on the drill pipe. The bottom hole assembly
13 would include the necessary drill bit and drilling
14 assembly and thus by rotation of the upper tubular member
15 12 transferring torque to the lower tubular member 14,
16 the hole may be drilled by rotation of the drill string.
17 This is achieved by right hand rotation as required.

18
19 With the bottom hole assembly of the bottom of the well,
20 fluid is circulated at a fixed rate, such as 5 bbls/min
21 and the circulation pressure noted. At this point the
22 mudpumps within the well are stopped. If the drill bit
23 and the drilling assembly is to be retrieved with the mud
24 motor, these portions can be fed through the bore 102 to
25 the surface, typically by insertion of a wire line
26 through the bore 102. Next the entire liner weight is
27 applied to the bottom of the well in order to achieve the
28 neutral point of the drilling liner system 100. Such a
29 neutral point allows the drill string to be rotated in a
30 left hand rotation in order that the shear screws shear
31 and the ports 44,60 align. This occurs by rotation of two
32 left hand rotations on the drill pipe.

33

1 In this partially engaged position, shown in Figure 3(b),
2 circulation is restarted at the previous flow rate and
3 the circulation pressure will now be reduced to indicate
4 that the ports 44,60 have aligned. The system 100 is open
5 to allow fluid to pass between the bore 102 and the
6 annulus 104. This reduction in circulation pressure
7 further shows that partial release has occurred and
8 indicates that the coupling 10 can be released after
9 cementing.

10

11 When the pressure loss is noted, the mud pumps are
12 stopped and the upper and lower members 12,14 are re-
13 engaged by applying two right hand rotations to the
14 system 100. Confirmation that the ports 44,60 are now
15 closed by being misaligned is confirmed by re-
16 establishing the previous circulation rate and confirming
17 that the pressure has returned to the first pressure
18 noted.

19

20 Cementation of the liner can now be performed by
21 injecting cement through the bore 102. It should be
22 noted that the system 100 can be advantageously
23 reciprocated and/or rotated so that the liner can be
24 reciprocated and/or rotated during the cementing process
25 to enhance the cementing operation. A displacement
26 wiper-plug is then launched through the bore 102 to
27 displace cement through the centre of the bore 102.

28

29 The entire liner weight is then re-applied to the bottom
30 and eight left hand rotations are applied to the coupling
31 10. This releases the upper tubular member 12 from the
32 lower tubular member 14 and the upper tubular member is
33 pulled clear of the lower tubular member and returned to .

1 the surface. Reverse circulation can be used to remove
2 excess cement as required prior to the string being
3 pulled out of the hole.

4
5 A further feature of the embodiment herein described, is
6 that of the provision of a liner seal stem if required.
7 Figure 4 shows a suitable liner seal stem, generally
8 indicated by reference numeral 106, which may be used
9 with the liner system 100 described hereinbefore.

10
11 The seal stem 106 comprises a cylindrical body 108 having
12 a bore 110 therethrough. At a base 112 of the stem 106
13 are located annular grooves 114 into which O-ring seals
14 116 are incorporated. The outer diameter 118 of a lower
15 portion of the stem 106 is sized such that it can fit
16 within the bore 50 of the lower tubular member 14.

17
18 When inserted into the lower tubular member 14 the O-
19 rings 116 will seal against the inner surface 56 of the
20 member 14, just below the radial port 60. Sloping
21 portions 120 on the outer surface 118 will meet with the
22 face 74 at the upper end 68 of the member 14. This will
23 provide an upper section 122 of the stem 106 at whose
24 distal end 124 is located a polished bore receptacle 126.

25
26 Thus when the stem 106 is inserted in the lower tubular
27 member 14, i.e. the setting sleeve, for the drilling
28 liner system 100 the stem 106 will provide a polished
29 bore receptacle 126 above the cemented liner.

30
31 Various modifications made by made to the invention
32 herein described without departing from the scope
33 thereof. For example, the number of projections located

1 on each of the tubular members may be varied as long as
2 it is noted that a substantial meeting of the straight
3 portions will occur on rotation of the two members
4 relative to each other. Further additional seals may be
5 provided around the radial ports to further prevent the
6 ingress of fluids to the screw threads in use.
7 Additionally while the system has primarily described the
8 use of the tool for cementing purposed it will be
9 recognised that the alignment of the radial ports
10 provides a passage both for cement and for cleaning fluid
11 from the central bore to the annulus and indeed walls or
12 casing within a well bore.

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